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First Named Inventor	Craig S. Gittleman et al.
Art Unit	1724
Examiner Name	Frank Lawrence
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ENCLOSURES *(Check all that apply)*

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SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Warn, Hoffmann, Miller & LaLone, P.C.		
Signature	John A. Miller		
Printed name	John A. Miller		
Date	8-15-06	Reg. No.	34,985

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	10/706,320
Filing Date:	November 12, 2003
Appellant:	Craig S. Gittleman et al.
Group Art Unit:	1724
Examiner:	Frank Lawrence
Title:	HYDROGEN PURIFICATION PROCESS USING PRESSURE SWING ADSORPTION FOR FUEL CELL APPLICATIONS
Attorney Docket:	GP-303297

APPELLANT'S FOURTH BRIEF

In response to the Notification of Non-Compliant Appeal Brief, this is Appellant's Fourth Brief filed in accordance with 37 CFR § 41.37 correcting Appellant's Third Brief filed July 13, 2006, which corrected Appellant's Second Brief filed May 23, 2006 filed in response to the Examiner's third Office Action mailed March 3, 2006 that reopened prosecution. Appellant's original Brief appealing the Examiner's Final Rejection mailed November 29, 2005 was filed on January 30, 2006. Appellant's Second Notice of Appeal, pursuant to 37 CFR § 41.31 was filed concurrently with Appellant's Second Brief. This Brief is being submitted in triplicate. Appellant believes that no fees are due.

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Table of Authorities

I. Real Party in Interest

The real party in interest for this appeal is General Motors Corporation of Detroit, Michigan, the assignee of the application.

II. Related Appeals and Interferences

There are no related appeals or interferences.

III. Status of the Claims

Claims 1-71 are pending in this application. All of the claims 1-71 are rejected. All of the claims 1-71 are being appealed.

Claims 1-8, 11, 14-17, 20-23, 26-33, 36, 39-42, 45-48, 51-62 and 65-71 stand rejected under 35 USC §102(b) as being anticipated by U.S. Patent No. 3,986,849 issued to Fuderer et al. (hereinafter Fuderer); Claims 13, 18, 19, 24, 25, 38, 43, 44, 49, 50, 63 and 64 stand rejected under 35 USC §103(a) as being unpatentable over Fuderer; Claims 9 and 34 stand rejected under 35 USC §103(a) as being unpatentable over Fuderer in view of U.S. Patent No. 5,820,656 issued to Lemcoff et al. (hereinafter Lemcoff '656); Claims 10, 35 and 55 stand rejected under 35 USC §103(a) as being unpatentable over Fuderer in view of U.S. Patent No. 5,807,423 issued to Lemcoff et al. (hereinafter Lemcoff '423); Claims 12 and 37 stand rejected under 35 USC §103(a) as being unpatentable over Fuderer in view of U.S. Patent No. 6,299,994 issued to Towler et al. (hereinafter Towler) or U.S. Patent Publication 2002/00110504 to Gittleman et al. (hereinafter Gittleman); Claims 6 and 7 stand rejected under 35 USC §112, first paragraph, as failing to comply with the written description requirement; and Claims 6, 7, 13, 15, 16, 38, 40, 41, 58, 60 and 61 stand rejected under 35 USC §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which

Appellant regards as the invention. Claims 30 and 31 have been objected to because the word "the" is missing. Appellant submits that this correction can be made by Examiner's Amendment upon indication that this application is allowable.

IV. Status of Amendments

All amendments have been entered.

V. Summary of the Claimed Subject Matter

Appellant's claimed invention is a pressure swing adsorption (PSA) system 10 for purifying a gas that has particular application for purifying hydrogen for a fuel cell as figure 1. The PSA system 10 includes a plurality of vessels 12, nine vessels in this embodiment, that include an adsorbent for adsorbing impurities in a feed gas to provide the purified gas. The PSA system 10 includes a feed manifold 20 that provides a feed gas to the vessels, a product manifold 22 that collects the product gas from a product end 16 of the vessels 12 and emits the product gas, and an exhaust manifold 24 that outputs an exhaust gas from the vessels 12. The PSA system 10 also includes at least one feed valve VF1-VF9 coupled between the feed manifold 20 and the plurality of vessels 12 for controlling the feed gas applied to the vessels 12, at least one product valve VP1-VP9 coupled between the vessels 12, a plurality of exhaust valves VE1-VE9 that allow the exhaust gas to be drawn from a feed end 14 of the vessels and a plurality of purge valves VR1-VR9.

Independent claim 1 claims a method for cycling the PSA system 10 through a predetermined sequence of steps that are shown in figure 2. These steps include, in sequence, a production stage where the feed gas is provided from the feed manifold 20 to the feed end 14 of the vessel 12, and product gas is drawn from the product end 16 of

the vessel into the product manifold 22 (paragraph 46); a first equalization down (E1 down) stage for reducing the pressure in the vessel 12 (paragraph 47); a second equalization down (E2 down) stage to further reduce the pressure in the vessel 12 (paragraph 48); a blow-down (BD) stage for reducing the pressure in the vessel 12 to an exhaust pressure (paragraph 49); a purge stage for purging the adsorbents in the vessel 12 (paragraph 50); a second equalization up (E2 up) stage for increasing the pressure in the vessel 12 (paragraph 51); a first equalization up (E1 up) stage for further increasing the pressure in the vessel 12 (paragraph 52); and a product pressurization (PP) stage for increasing the pressure in the vessel 12 to the production pressure (paragraph 53). Each vessel 12 in the system 10 follows this sequence of steps, where certain vessels are performing certain steps at a particular moment in time.

Independent method claim 28 claims a method for cycling the PSA system 10 through a predetermined sequence of steps that are shown in figure 2. These steps include, in sequence, operating each vessel 12 of the plurality of vessels 12 in a production stage for a plurality of cycle periods, wherein operating the vessel 12 in the production stage includes delivering the feed gas to the feed end 14 of the vessel 12 and drawing the product gas from the product end 16 of the vessel 12 (paragraph 46); operating each vessel 12 of the plurality of vessels 12 in at least one equalization downstage following the production stage for at least one cycle period, wherein operating the vessel 12 in the equalization downstage includes coupling the product end 16 of the vessel 12 to the product end 16 of another vessel 12 that is at a lower pressure to lower the pressure in the vessel 12 (paragraphs 47 and 48); operating each vessel 12 of the plurality of vessels 12 in a blow-down stage directly following the at least one equalization downstage for at least one cycle period, wherein operating the vessel 12 in the blow-down stage further reduces the pressure in the vessel 12 to an

exhaust pressure (paragraph 49); operating each vessel 12 of the plurality of vessels 12 in a purge stage following the blow-down stage, wherein operating the vessel 12 in the purge stage includes feeding reduced-pressure product gas to the product end 16 of the vessel 12 and emitting the exhaust gas to the feed end 14 of the vessel 12 (paragraph 50); operating each vessel 12 of the plurality of vessels 12 in at least one equalization upstage following the purge stage for at least one cycle period, wherein operating the vessel 12 in the at least one equalization upstage includes increasing the pressure in the vessel 12 (paragraphs 51 and 52); and operating each vessel 12 of the plurality of vessels 12 in a product pressurization stage directly following the at least one equalization upstage for at least one cycle period, wherein operating the vessel 12 in the product pressurization stage includes pressurizing the vessel 12 with the product gas to a product pressure (paragraph 53).

Independent claim 52 claims the pressure swing adsorption system 10 and includes the feed manifold 20, the product manifold 22, the exhaust manifold 24, the plurality of vessels 12, at least one feed valve VF1-VF9 and at least one product valve VP1-VP9, all shown in figure 1. The PSA system 10 operates by a certain PSA cycle including operating each vessel 12 of the plurality of vessels 12 in a production stage for a plurality of cycle periods, wherein operating the vessel 12 in the production stage includes delivering the feed gas to the feed end 14 of the vessel 12 and drawing the product gas from the product end 16 of the vessel 12 (paragraph 46); operating each vessel 12 of the plurality of vessels 12 in a first equalization downstage following the production stage for at least one cycle period, wherein operating the vessel 12 in the first equalization downstage includes coupling the product end 16 of the vessel 12 to the product end 16 of an adjacent vessel 12 that is at a lower pressure to lower the pressure in the vessel (paragraph 47); operating each vessel 12 of the plurality of vessels 12 in a

second equalization downstage following the first equalization downstage for at least one cycle period, wherein operating the vessel 12 in a second equalization downstage includes coupling the product end 16 of the vessel 12 to the product end 16 of another adjacent vessel 12 that is at a purge pressure to further lower the pressure in the vessel 12 (paragraph 48); operating each vessel 12 of the plurality of vessels 12 in a blow-down stage directly following the second equalization downstage for at least one cycle period, wherein operating the vessel 12 in the blow-down stage further reduces the pressure in the vessel 12 to an exhaust pressure (paragraph 49); operating each vessel 12 of the plurality of vessels 12 in a purge stage following the blow-down stage over a plurality of cycle periods, wherein operating the vessel 12 in the purge stage includes feeding reduced-pressure product gas into the product end 16 of the vessel 12 and emitting the exhaust gas through the feed end 14 of the vessel 12 (paragraph 50); operating each vessel 12 of the plurality of vessels 12 in a second equalization upstage following the purge stage for a least one cycle period, wherein operating the vessel 12 in the second equalization upstage includes coupling the product end 16 of the vessel 12 to the product end 16 of an adjacent vessel 12 that is at a higher pressure to increase the pressure in the vessel 12 (paragraph 51); operating each vessel 12 of the plurality of vessels 12 in a first equalization upstage following the second equalization upstage for at least one cycle period, wherein operating the vessel 12 in the first equalization upstage includes coupling the product end 16 of the vessel 12 to the product 16 of another adjacent vessel 12 that is at a higher pressure to further increase the pressure in the vessel 12 (paragraph 52); and operating each vessel 12 of the plurality of vessels 12 in a product pressurization stage directly following the first equalization upstage for at least one cycle period, wherein operating the vessel 12 in a product pressurization stage

includes pressuring the vessel 12 with product gas in the product manifold 22 to a product pressure for the production stage (paragraph 53).

VI. Grounds of Rejection to be Reviewed on Appeal

Whether claims 1-8, 11, 14-17, 20-23, 26-33, 36, 39–42, 45-48, 51-62 and 65-71 should be rejected under 35 USC §102(b) as being anticipated by Fuderer; whether claims 13, 18, 19, 24, 25, 38, 43, 44, 50, 63 and 64 should be rejected under 35 USC §103(a) as being unpatentable over Fuderer; whether claims 9 and 34 should be rejected under 35 USC §103(a) as being unpatentable over Fuderer in view of Lemcoff '656; whether claims 10, 35 and 55 should be rejected under 35 USC §103(a) as being unpatentable over Fuderer in view of Lemcoff '423; whether claims 12 and 37 should be rejected under 35 USC §103(a) as being unpatentable over Fuderer in view of Towler or Gittleman; whether claims 6 and 7 should be rejected under 35 USC §112, second paragraph, as failing to comply with the written description requirement; and whether claims 6, 7, 13, 15, 16, 38, 40, 41, 58, 60 and 61 should be rejected under 35 USC §112, second paragraph, as being indefinite.

VII. Argument

A. Independent claims 1, 28 and 52 are not anticipated by Fuderer

1. Anticipation

MPEP 2131 states that in order for a claim to be anticipated, the reference must teach <u>every</u> element of the claim. As will be discussed below, Appellant respectfully submits that Fuderer does not teach every element of Appellant's independent claims 1, 28 and 52.

2. Independent claims 1, 28 and 52

Each of independent claims 1, 28 and 52 has a second equalization down stage that includes coupling the product end of the vessel to a product end of an adjacent vessel that is at a purge pressure. Further, each of the independent claims 1, 28 and 52 include a blow-down stage directly following the second equalization down stage that reduces the pressure in the vessel to an exhaust pressure. Also, each of the independent claims includes a purge stage following the blow-down stage that includes feeding reduced pressure product gas into the product end of the vessel and emitting the exhaust gas through the feed end of the vessel.

3. Discussion of Fuderer

Fuderer teaches a PSA system that includes a plurality of vessels for purifying a hydrogen product gas. The Fuderer PSA system is intended to provide very high purity hydrogen, typically on the order of 99.9999% (column 1, line 20). Further, as discussed in the various examples in Fuderer, the PSA system operates at a pressure of about 10 atmospheres and above. Because Appellant's PSA system does not need to provide such a high purity of hydrogen, it is does not need to operate at such high pressures, thus the sequence of steps in the PSA process can be different than that taught by Fuderer.

Figure 2 of Fuderer shows a sequence of PSA steps that are discussed at column 8, lines 20-36. The Fuderer process includes three equalization down steps E1D, E2D and E3D, followed by a co-current depressurization providing purge gas (PP) step (column 8, lines 29 and 30). A blow-down (BD) stage follows the PP stage. Column 8, lines 51-55 appears to discuss the PP stage, stating "purge gas is entering the bed 4 discharge end through purge valve 34 and is being supplied therethrough

through the purge gas manifold by cocurrent depressurization gas released from the discharge end of the bed 6 through valve 36."

In Appellant's claimed invention, the blow-down stage immediately follows an equalization down stage. In Fuderer, the blow-down stage immediately follows the PP stage, and <u>not</u> an equalization down stage. Fuderer does not appear to describe how the vessels are interconnected for the equalization down stages, but clearly distinguishes the pressure equalization down stages as being different from the PP stage. In Appellant's claimed invention, the PP stage defined by Fuderer is not performed where purge gas is flowed through the vessel to the purge gas manifold. Appellant's claims clearly recite that the blow-down stage immediately follows an equalization down stage, where the equalization down stage is performed by coupling a product end of the vessel to the product end of an adjacent vessel. The PP stage of Fuderer that precedes the blow-down stage does not include vessel coupling in this manner. Therefore, Appellant respectfully submits that Fuderer cannot anticipate the independent claims because this element is not found in Fuderer.

Further, Appellant's claimed purge stage includes feeding reduced-pressure product gas into the product end of the vessel and emitting the exhaust gas through the feed end of the vessel. It does not appear that Fuderer PSA system specifically performs this operation during the purge stage. Column 8, lines 51-58 appears to discuss the sequence of the PP step, the BD step and the purge step stating, "[p]urge gas is entering the bed 4 discharge end through purge valve 34 and is being supplied thereto through the purge gas manifold by cocurrent depressurization gas released from the discharge end of bed 6 through valve 36. At the same time counter current blowdown gas is released from the bed 5 inlet end through waste valve 45 and released to the environment through the waste gas manifold." It does not appear that

Fuderer teaches feeding reduced-pressure product gas into the vessel to purge the vessel, or the combination of an equalization down stage, a blow down stage and then a purge stage as specifically claimed by Appellant. Therefore, Appellant submits that Fuderer does not anticipate Appellant's claimed invention for that reason.

B. Dependent claims 2-8, 11, 14-17, 20-23, 26, 27, 29-33, 36, 39-42, 51, 53-62 and 65-71 are not anticipated by Fuderer

Concerning dependent claim 7, it does not appear that Fuderer teaches a fourth equalization down stage following a third equalization down stage and a fourth equalization up stage prior to a third equalization upstage, and therefore cannot anticipate this claim.

Concerning dependent claims 22, 23, 47, 48, 67 and 68, it does not appear that the Fuderer PSA system operates at a pressure of 7 atmospheres or less, and it is believed that Fuderer operates at a much higher pressure, over 10 atmospheres (1 psia = 0.068046 atmospheres), to get higher gas purities, see, for example, column 2, lines 46-65, column 3, lines 15-22 and column 9, lines 35-54. Therefore, Appellant respectfully submits that Fuderer cannot anticipate these claims.

Dependent claims 2-6, 8, 11, 14-17, 20, 26, 27, 29-33, 36, 39-42, 45, 46, 51-62, 65-67 and 69-71 are also not anticipated by Fuderer because the independent claims 1, 28 and 52 recite a blow-down stage immediately following an equalization down stage, where the equalization down stage is performed by coupling a product end of the vessel to the product end of an adjacent vessel and feeding reduced-pressure product gas into the product end of the vessel and emitting the exhaust gas to the feed end of the vessel which Fuderer does not teach, as discussed above.

C. Dependent claims 13, 18, 19, 24, 38, 43, 44, 49, 50, 63 and 64 are not obvious in view of Fuderer

Concerning dependent claims 19, 44 and 64, it does not appear that Fuderer teaches first and second adsorbents in the vessels, where a first adsorbent is selected from the group consisting Zeolite 5A, Zeolite LiX, and combinations thereof, and the second adsorbent is selected from the group consisting of activated carbon, activated alumina, Zeolite 13X, Zeolite 4A and combinations thereof, where the first and second adsorbents are positioned in the vessels so that the feed gas first passes over the second adsorbent before contacting the first adsorbent. Therefore, Appellant respectfully submits that Fuderer alone cannot make these claims obvious.

Concerning dependent claims 13, 18, 24, 38, 43, 49, 50 and 63, Appellant submits that Fuderer does not teach a blow-down step immediately following an equalization down stage, where the equalization down stage is performed by coupling a product end of the vessel to the product end of an adjacent vessel and feeding reduced pressure product gas into the product end of the vessel and emitting the exhaust gas to the feed end of the vessel, as discussed above concerning the independent claims 1, 28 and 52. Therefore, Appellant submits that Fuderer alone cannot make these claims obvious.

D. Dependent claims 9 and 34 are not obvious in view of Fuderer and Lemcoff '656

Lemcoff '656 discloses a PSA system. It is believed that the Examiner is relying on Lemcoff '656 to teach the use of rotary valves at the feed and product end of the adsorber vessels. However, Appellant submits that Lemcoff '656 fails to teach or suggest the sequence of PSA steps as discussed above, and therefore cannot be combined with Fuderer to make Appellant's claimed invention obvious.

E. Dependent claims 10, 35 and 55 are not obvious in view of Fuderer and Lemcoff '423

Lemcoff '423 also discloses a PSA system using rotary valves. It is believed that the Examiner is relying on Lemcoff '423 to teach a single rotary valve type of system. However, Appellant submits that Lemcoff '423 fails to teach or suggest the sequence of PSA cycle steps as discussed above, and therefore, cannot be combined with Fuderer et al. to make Appellant's claimed invention obvious.

F. Dependent claims 12 and 37 are not obvious in view of Fuderer and Towler or Gittleman

Towler discloses a system and method for providing hydrogen to a fuel cell. Gittleman discloses an apparatus for removing carbon monoxide from a hydrogen gas stream for a hydrogen fuel cell system. It is believed that the Examiner is relying on Towler and Gittleman to teach providing purified product hydrogen to a fuel cell. However, Towler and Gittleman do not teach or suggest PSA systems, and therefore fail to provide the teaching missing from Fuderer et al. to make Appellant's claimed invention obvious.

G. Claims 6 and 7 do comply with the written description requirement of 35 USC §112, first paragraph

Dependent claim 6 states that the method includes a third equalization down stage after the second equalization down stage. Claim 7 states that the method includes a fourth equalization down stage after the third equalization down stage. Appellant submits that one of ordinary skill in the art would recognize that by stating that the method includes a blow-down stage directly following the second equalization down stage in claim 1, the blow-down stage directly follows the <u>last</u> equalization down stage in the cycle. Therefore, by adding more equalization down stages in dependent claims 6

and 7, as discussed in paragraph 56 of the specification, one of ordinary skill would know that the blow-down stage would no longer follow the second equalization down stage, but would directly follow the last equalization down stage. Appellant respectfully submits that they have met the §112, first paragraph, written description requirement because the specification conveys with reasonable clarity to those skilled in the art that the inventors were in possession of the invention, and that the invention, in that context is claimed. MPEP 2163.02. Therefore, Appellant submits that claims 6 and 7 do comply with the written description requirement.

H. Claims 6, 7, 13, 15, 16, 38, 40, 41, 58, 60 and 62 are definite under 35 USC §112, second paragraph

Appellant submits that claims 6 and 7 are definite as discussed above because one of ordinary skill in the art would recognize that the blow-down stage would directly follow the last equalization down stage. MPEP 2173.05(b) states the fact that claim language, including terms of degree, may not be precise, does not automatically make the claim indefinite under 35 USC §112, second paragraph. Acceptability of the claim language depends on whether one of ordinary skill in the art would understand what is claimed in light of the specification. Appellant submits that the specification discussing the addition of more equalization down stages, for example, paragraph 56, renders dependent claim 6 and 8 precise and definite.

Appellant further submits that claims 13, 15, 16, 38, 40, 41, 58, 60 and 61 are definite because one of ordinary skill in the fuel cell art would know that the hydrogen in the reformate gas is a gas, and whether the percentage of hydrogen in the reformate gas was a mole percent, a volume percent or a weight percent. MPEP 2173.02 states that a claim is not indefinite if it meets the threshold requirements of clarity and precision, which is analyzed based on the content of the particular application

disclosure, the teachings of the prior art, and a claim interpretation that would be given by one possessing the ordinary skill level in the pertinent art at the time the invention was made. Therefore, Appellant submits that these claims are definite under the prevailing standards of §112, second paragraph.

VIII. Conclusion

Appellant respectfully submits that Claims 1-8, 11, 14-17, 20-23, 26-33, 36, 39-42, 45-48, 51-62 and 65-71 are not anticipated by Fuderer, Claims 13, 18, 19, 24, 25, 38, 43, 44, 49, 50, 63 and 64 are not obvious in view of Fuderer, claims 9 and 34 are not obvious in view of Fuderer and Lemcoff '656, Claims 10, 35 and 55 are not obvious in view of Fuderer and Lemcoff '423, claims 12 and 37 are not obvious in view of Fuderer and Towler or Gittleman, Claims 6 and 7 do comply with the written description requirement of §112, first paragraph, and claims 6, 7, 13, 15, 16, 38, 40, 41, 58, 60 and 61 are definite in view of §112, second paragraph. It is therefore respectfully requested that the Examiner's Final Rejection under 35 USC §112, 35 USC §102(b) and §103(a) be reversed, and that Appellant's claims be allowed.

Respectfully submitted,

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CLAIMS APPENDIX

COPY OF CLAIMS INVOLVED IN THE APPEAL

1. A method for cycling a pressure swing adsorption (PSA) system, said PSA system receiving a feed gas and emitting a purified product gas and an exhaust gas, said method comprising:

providing a plurality of vessels, each vessel including an adsorbent for adsorbing impurities in the feed gas, each vessel further including a feed end responsive to the feed gas and emitting the exhaust gas, and a product end that emits the product gas;

operating each vessel of the plurality of vessels in a production stage for a plurality of cycle periods, wherein operating the vessel in the production stage includes delivering the feed gas to the feed end of the vessel and drawing the product gas from the product end of the vessel;

operating each vessel of the plurality of vessels in a first equalization down stage following the production stage for at least one cycle period, wherein operating the vessel in the first equalization down stage includes coupling the product end of the vessel to the product end of an adjacent vessel that is at a lower pressure to lower the pressure in the vessel;

operating each vessel of the plurality of vessels in a second equalization down stage following the first equalization down stage for at least one cycle period, wherein operating the vessel in the second equalization down stage includes coupling the product end of the vessel to the product end of another adjacent vessel that is at a purge pressure to further lower the pressure in the vessel;

operating each vessel of the plurality of vessels in a blow-down stage directly following the second equalization down stage for at least one cycle period, wherein operating the vessel in the blow-down stage further reduces the pressure in the vessel to an exhaust pressure;

operating each vessel of the plurality of vessels in a purge stage following the blow-down stage over a plurality of cycle periods, wherein operating the vessel in the purge stage includes feeding reduced-pressure product gas into the product end of the vessel and emitting the exhaust gas through the feed end of the vessel;

operating each vessel of the plurality of vessels in a second equalization up stage following the purge stage for at least one cycle period, wherein operating the

vessel in the second equalization up stage includes coupling the product end of the vessel to the product end of an adjacent vessel that is at a higher pressure to increase the pressure in the vessel;

operating each vessel of the plurality of vessels in a first equalization up stage following the second equalization up stage for at least one cycle period, wherein operating the vessel in the first equalization up stage includes coupling the product end of the vessel to the product end of another adjacent vessel that is at a higher pressure to further increase the pressure in the vessel;

operating each vessel of the plurality of vessels in a product pressurization stage directly following the first equalization up stage for at least one cycle period, wherein operating the vessel in the product pressurization stage includes pressurizing the vessel with product gas to a product pressure; and

operating each vessel of the plurality of vessels in the production stage following the product pressurization stage.

2. The method according to claim 1 wherein operating each vessel in the first equalization down stage includes operating the adjacent vessel in the second equalization down stage during the previous cycle period and operating the adjacent vessel in the first equalization up stage while the vessel is operating in the first equalization down stage.

3. The method according to claim 1 wherein operating each vessel in the second down equalization stage includes operating the other adjacent vessel in the purge stage during the previous cycle period and operating the other adjacent vessel in the second equalization up stage while the vessel is operating in the second equalization down stage.

4. The method according to claim 1 wherein operating each vessel in the second equalization up stage includes operating the adjacent vessel in the first equalization down stage during a previous cycle period and operating the adjacent vessel in the second equalization down stage while the vessel is operating in the second equalization up stage.

5. The method according to claim 1 wherein operating each vessel in the first equalization up stage includes operating the other adjacent vessel in the production stage during the previous cycle period, and operating the other adjacent vessel in the first equalization down stage when the vessel is operating in the first equalization up stage.

6. The method according to claim 1 further comprising operating each vessel in a third equalization down stage at the next cycle period following operating the vessel in the second equalization down stage and operating the vessel in a third equalization up stage during a cycle period just prior to operating the vessel in the second equalization up stage.

7. The method according to claim 6 further comprising operating each vessel in a fourth equalization down stage at the next cycle period following operating the vessel in the third equalization down stage and at a cycle period just prior to the blow-down stage, and operating the vessel in a fourth equalization up stage during a cycle period just prior to the third equalization up stage and just after the purge stage.

8. The method according to claim 1 wherein the plurality of vessels are coupled together through a plurality of open/shut valves.

9. The method according to claim 1 wherein the plurality of vessels are coupled together through a rotary feed valve and a rotary product valve.

10. The method according to claim 1 wherein the plurality of vessels are coupled together through a single rotary valve communicating with both the feed end and the product end of each vessel.

11. The method according to claim 1 wherein the PSA system purifies a reformate feed gas into a hydrogen product gas.

12. The method according to claim 11 wherein the hydrogen product gas is fed directly into a fuel cell.

13. The method according to claim 11 wherein the reformate feed gas contains less than 59% hydrogen.

14. The method according to claim 11 wherein the product gas recovers at least 70% of the hydrogen that is in the feed gas.

15. The method according to claim 11 wherein the product gas contains at least 95% hydrogen.

16. The method according to claim 11 wherein the product gas contains at least 99% hydrogen.

17. The method according to claim 11 wherein the product gas contains less than 1ppm of carbon monoxide.

18. The method according to claim 11 wherein a first adsorbent in the vessels is selected from the group consisting of zeolite 5A, zeolite LiX and combinations thereof.

19. The method according to claim 18 wherein a second adsorbent in the vessels is selected from the group consisting of activated carbon, activated alumina, zeolite 13X, zeolite 4A and combinations thereof placed at the feed end of the vessel so that the feed gas first passes over the second adsorbent before contacting the first adsorbent.

20. The method according to claim 11 wherein the adsorbents in the vessels remove carbon monoxide, carbon dioxide, nitrogen and water.

21. The method according to claim 20 wherein the adsorbents in the vessels remove one or more of the impurities from the feed gas selected from the group consisting of methane, ethane, propane, butane, ethylene, propylene, hydrogen sulfide and NH_3.

22. The method according to claim 11 wherein the PSA system operates at a pressure below 7 atmospheres.

23. The method according to claim 22 wherein the PSA system operates at a pressure between 3 and 5 atmospheres.

24. The method according to claim 11 wherein the PSA system operates at a temperature between 20 and 100° C.

25. The method according to claim 24 wherein the PSA system operates at a temperature between 60° and 100° C.

26. The method according to claim 1 wherein providing a plurality of vessels includes providing at least five vessels.

27. The method according to claim 26 wherein providing a plurality of vessels includes providing nine vessels.

28. A method for cycling a pressure swing adsorption (PSA) system, said PSA system receiving a feed gas and emitting a purified product gas and an exhaust gas, said PSA system including a plurality of adsorbent vessels, each vessel including an adsorbent for adsorbing impurities in the feed gas, each vessel including a feed end responsive to the feed gas and emitting the exhaust gas, and a product end that emits the product gas, said method comprising:

operating each vessel of the plurality of vessels in a production stage for a plurality of cycle periods, wherein operating the vessel in the production stage includes delivering the feed gas to the feed end of the vessel and drawing the product gas from the product end of the vessel;

operating each vessel of the plurality of vessels in at least one equalization down stage following the production stage for at least one cycle period, wherein operating the vessel in the equalization down stage includes coupling the product end of the vessel to the product end of another vessel that is at a lower pressure to lower the pressure in the vessel;

operating each vessel of the plurality of vessels in a blow-down stage directly following the at least one equalization down stage for at least one cycle period,

wherein operating the vessel in the blow-down stage further reduces the pressure in the vessel to an exhaust pressure;

operating each vessel of the plurality of vessels in a purge stage following the blow-down stage, wherein operating the vessel in the purge stage includes feeding reduced-pressure product gas into the product end of the vessel and emitting the exhaust gas through the feed end of the vessel;

operating each vessel of the plurality of vessels in at least one equalization up stage following the purge stage for at least one cycle period, wherein operating the vessel in the at least one equalization up stage includes increasing the pressure in the vessel;

operating each vessel of the plurality of vessels in a product pressurization stage directly following the at least one equalization up stage for at least one cycle period, wherein operating the vessel in the product pressurization stage includes pressurizing the vessel with the product gas to a product pressure; and

operating each vessel of the plurality of vessels in the production stage following the product pressurization stage.

29. The method according to claim 28 wherein operating the vessel in the at least one equalization up stage includes coupling the product end of the vessel to the product end of another vessel that is at a higher pressure.

30. The method according to claim 28 wherein operating the vessel in at least one equalization up stage includes coupling the feed end of the vessel to the feed end of another vessel that is at a higher pressure.

31. The method according to claim 28 wherein operating the vessel in at least one equalization up stage includes coupling the product end of the vessel to the product end of another vessel that is at a higher pressure and coupling the feed end of the vessel to the feed end of another vessel that is at a higher pressure.

32. The method according to claim 28 wherein operating the vessel in at least one equalization down stage includes operating the vessel in a plurality of consecutive equalization down stages to reduce the pressure of the vessel over more than one cycle period, and wherein operating the vessel in at least one equalization up stage includes

operating the vessel in a plurality of consecutive equalization up stages to increase the pressure of the vessel over more than one cycle period.

33. The method according to claim 28 wherein the plurality of vessels are coupled together through a plurality of open/shut valves.

34. The method according to claim 28 wherein the plurality of vessels are coupled together through a rotary feed valve and a rotary product valve.

35. The method according to claim 28 wherein the plurality of vessels are coupled together through a single rotary valve communicating with both the feed end and the product end of each vessel.

36. The method according to claim 28 wherein the PSA system purifies a reformate gas into a hydrogen product gas.

37. The method according to claim 36 wherein the hydrogen product gas is fed directly into a fuel cell.

38. The method according to claim 36 wherein the reformate feed gas contains less than 59% hydrogen.

39. The method according to claim 36 wherein the product gas recovers at least 70% of the hydrogen that is in the feed gas.

40. The method according to claim 36 wherein the product gas contains at least 95% hydrogen.

41. The method according to claim 36 wherein the product gas contains at least 99% hydrogen.

42. The method according to claim 36 wherein the product gas contains less than 1 ppm of carbon monoxide.

43. The method according to claim 36 wherein a first adsorbent in the vessels is selected from the group consisting of zeolite 5A, zeolite LiX, and combinations thereof.

44. The method according to claim 43 wherein a second adsorbent in the vessels is selected from the group consisting of activated carbon, activated alumina, zeolite 13X, zeolite 4A and combinations thereof placed at the feed end of the adsorbent vessels so that the feed gas first passes over the second adsorbent before contacting the first adsorbent.

45. The method according to claim 36 wherein the adsorbents in the vessels remove carbon monoxide, carbon dioxide, nitrogen, and water.

46. The method according to claim 45 wherein the adsorbents in the vessels remove one or more of the impurities from the feed gas selected from the group consisting of methane, ethane, propane, butane, ethylene, propylene, hydrogen sulfide and NH_3.

47. The method according to claim 36 wherein the PSA system operates at a pressure below 7 atmospheres.

48. The method according to claim 47 wherein the PSA system operates at a pressure between 3 and 5 atmospheres.

49. The method according to claim 36 wherein the PSA system operates at a temperature between 20 and 100° C.

50. The method according to claim 49 wherein the PSA system operates at a temperature between 60 and 100° C.

51. The method according to claim 28 wherein providing a plurality of vessels includes providing at least five vessels.

52. A pressure swing adsorption (PSA) system for purifying a feed gas into a product gas, said system comprising:

a feed manifold responsive to the feed gas;

a product manifold outputting the product gas;

an exhaust manifold outputting an exhaust gas including impurities from the feed gas;

a plurality of vessels responsive to the feed gas from the feed manifold and outputting the product gas to the product manifold, said plurality of vessels including an adsorbent for adsorbing the impurities in the feed gas;

at least one feed valve coupled between the feed manifold and the plurality of vessels for controlling the feed gas applied to the vessels; and

at least one product valve coupled between the vessels and the product manifold for controlling the product gas drawn from the vessels to the product manifold, wherein the PSA system operates by a predetermined PSA cycle, said PSA cycle including operating each vessel of the plurality of vessels in a production stage for a plurality of cycle periods, wherein operating the vessel in the production stage includes delivering the feed gas to the feed end of the vessel and drawing the product gas from the product end of the vessel, operating each vessel of the plurality of vessels in a first equalization down stage following the production stage for at least one cycle period, wherein operating the vessel in the first equalization down stage includes coupling the product end of the vessel to the product end of an adjacent vessel that is at a lower pressure to lower the pressure in the vessel, operating each vessel of the plurality of vessels in a second equalization down stage following the first equalization down stage for at least one cycle period, wherein operating the vessel in the second equalization down stage includes coupling the product end of the vessel to the product end of another adjacent vessel that is at a purge pressure to further lower the pressure in the vessel, operating each vessel of the plurality of vessels in a blow-down stage directly following the second equalization down stage for at least one cycle period, wherein operating the vessel in the blow-down stage further reduces the pressure in the vessel to an exhaust pressure, operating each vessel of the plurality of vessels in a purge stage following the blow-down stage over a plurality of cycle periods, wherein operating the vessel in the purge stage includes feeding reduced-pressure product gas into the product end of the vessel and emitting the exhaust gas through the feed end of the vessel, operating each vessel of the plurality of vessels in a second equalization up

stage following the purge stage for at least one cycle period, wherein operating the cycle in the second equalization up stage includes coupling the product end of the vessel to the product end of an adjacent vessel that is at a higher pressure to increase the pressure in the vessel, operating each vessel of the plurality of vessels in the first equalization up stage following a second equalization up stage for at least one cycle period, wherein operating the vessel in the first equalization up stage includes coupling the product end of the vessel to the product end of another adjacent vessel that is at a higher pressure to further increase the pressure in the vessel, and operating each vessel of the plurality of vessels in a product pressurization stage directly following the first equalization up stage for at least one cycle period, wherein operating the vessel in a product pressurization stage includes pressurizing the vessel with product gas from the product manifold to a product pressure for the production stage.

53. The system according to claim 52 wherein the at least one product valve is a plurality of product valves, a plurality of purge valves and a plurality of equalization valves.

54. The system according to claim 52 wherein the at least one feed valve is a plurality of feed valves and a plurality of exhaust valves.

55. The system according to claim 52 wherein the at least one feed valve is a single rotary feed valve, and the at least one product valve is a single rotary product valve.

56. The system according to claim 52 wherein the PSA system purifies a reformate feed gas into a hydrogen product gas.

57. The system according to claim 56 wherein the hydrogen product gas is fed directly into a fuel cell.

58. The system according to claim 56 wherein the reformate feed gas contains less than 59% hydrogen.

59. The system according to claim 56 wherein the product gas recovers at least 70% of the hydrogen that is in the feed gas.

60. The system according to claim 56 wherein the product gas contains at least 95% hydrogen.

61. The system according to claim 56 wherein the product gas contains at least 99% hydrogen.

62. The system according to claim 56 wherein the product gas contains less than 1 ppm of carbon monoxide.

63. The system according to claim 56 wherein a first adsorbent in the vessels is selected from the group consisting of zeolite 5A, zeolite LiX, and combinations thereof.

64. The system according to claim 63 wherein a second adsorbent in the vessels is selected from the group consisting of activated carbon, activated alumina, zeolite 13X, zeolite 4A and combinations thereof placed at the feed end of the adsorbent vessels so that the feed gas first passes over the second adsorbent before contacting the first adsorbent.

65. The system according to claim 56 wherein the adsorbents in the vessels remove carbon monoxide, carbon dioxide, nitrogen, and water.

66. The system according to claim 65 wherein the adsorbents in the vessels remove one or more of the impurities from the feed gas selected from the group consisting of methane, ethane, propane, butane, ethylene, propylene, hydrogen sulfide and NH_3.

67. The system according to claim 56 wherein the PSA system operates at a pressure below 7 atmospheres.

68. The system according to claim 67 wherein the PSA system operates at a pressure between 3 and 5 atmospheres.

69. The system according to claim 56 wherein the PSA system operates at a temperature between 20 and 100° C.

70. The system according to claim 69 wherein the PSA system operates at a temperature between 60 and 100° C.

71. The system according to claim 52 wherein the plurality of vessels is at least five vessels.

EVIDENCE APPENDIX

There is no evidence pursuant to §1.130, §1.131 or §1.132.

RELATED PROCEEDINGS APPENDIX

There are no decisions rendered by a court or the Board in any proceeding identified in Section II of this Appeal Brief.